3-6-1990

THE EVOLUTION OF VERTEBRATE PEST MANAGEMENT--THE SPECIES VERSUS SYSTEMS APPROACH

Scott E. Hygnstrom
University of Nebraska-Lincoln, shygnstrom1@unl.edu

THE EVOLUTION OF VERTEBRATE PEST MANAGEMENT--THE SPECIES VERSUS SYSTEMS APPROACH

SCOTT E. HYGNSTROM, Department of Forestry, Fisheries and Wildlife, University of Nebraska-Lincoln 68583.

ABSTRACT: Wildlife management has evolved through a series of stages, with early efforts directed toward individual species. Since the late 1800s, however, more wildlife applications have incorporated a systems approach, where communities are managed to promote the quality, quantity, and fitness of most associated species. Vertebrate pest management has followed a similar course of development, although it has lagged behind in addressing the concept of systems management. I propose that a systems approach to vertebrate pest management should include the consideration of all potential problem species of an area or situation and should integrate damage prevention and control strategies that minimize damage caused by those species identified as economically or socially detrimental. The systems approach can provide long-term benefits and is therefore generally cost-effective. It works in accordance with integrated pest management principles and proactive interdisciplinary programming and can be incorporated into agricultural profitability and sustainable agriculture initiatives. Examples where the systems approach to vertebrate pest management could be feasible are provided.

Proc. 14th Vertebr. Pest Conf. (L.R. Davis and R.E. Marsh, Eds.)
Published at Univ. of Calif., Davis. 1990.

INTRODUCTION

Game (wildlife) management has evolved through a series of stages (Leopold 1933). Early efforts in management were directed toward individual species that were valued for food, fiber, and sport. Single-species management continues to be important, but the emphasis in wildlife management has changed in the twentieth century toward management at the community level-a systems approach to wildlife management. Fisheries management has progressed much further and is firmly based in ecosystem theory (Wagner 1969). Wagner proclaimed the importance of an ecosystem approach to wildlife management, which should endorse a holistic philosophy and management of natural communities rather than single species.

The earliest accounts of vertebrate pest management refer to problems with individual species. Ancient Islamic writings state that "those people who kill rats will be rewarded in heaven" (R. M. Timm, pers. comm.). Egyptians before 2800 B.C. viewed rats and mice as undesirable and used cats to reduce their numbers (Keeler 1931). These examples illustrate a single-species approach to vertebrate pest management. The field of vertebrate pest management has changed through the years (Spencer 1982, Lee 1986). Single-species management still predominates in vertebrate pest management, as it has in wildlife management. It is apparent, though, that vertebrate pest management has lagged behind wildlife and fisheries management in its evolution toward the level of systems management. The objectives of this paper are to 1) compare the evolution of vertebrate pest management with wildlife management and 2) promote a systems approach to vertebrate pest management where practical.

THE EVOLUTION OF GAME (WILDLIFE) MANAGEMENT

In 1933, Leopold discussed the evolution of wildlife management. He identified five stages through which wildlife management had progressed: (1) Restriction of hunting, (2) Predator control, (3) Reservation of game lands (as parks, forests, refuges, etc.), (4) Artificial replenishment (restocking and game farming), and (5) Environmental controls (control of food, cover, special factors and disease).

Protection of game species through restriction of hunting acted primarily on the species level. In the thirteenth century, Kublai Kahn closed hunting seasons on game species during the spring and summer to promote those species. There are several examples from fifteenth to nineteenth century Europe, in which preferred species were afforded similar protection through customs and written laws (Leopold 1933). By the late 1700s, all of the newly established American colonies had enacted closed seasons and other game laws (Palmer 1912).

Similarly, predator control and artificial propagation were applied to promote the welfare of individual species. The colonists actively practiced predator control to protect game species as well as domestic animals. The first government predator control agent was hired by William Penn in 1705 (Allen 1974). The first planting of an exotic species, the gray partridge (Perdix perdix), in America occurred on a New Jersey estate in 1790 (Phillips 1928). Hundreds of attempts to introduce exotic species have occurred since then (Allen 1974, Laycock 1966). The first state-owned game farm was established in Illinois in 1905 and focussed on the production of ring-necked pheasants (Phasianus colchicus) (Palmer 1912).

Wildlife management changed, however, in the United States in the late 1800s and early 1900s. Several large land areas were set aside as national parks, forests, and refuges. Hunting and trapping were regulated in these areas, and Leopold (1933) viewed them as "half-way points" between the ideas of restriction and environmental controls. Wildlife management in the United States did not incorporate activities associated with environmental controls until 1910, when large-scale habitat management was implemented on national forests and other publicly owned lands. Stoddard (1931) manipulated habitat for quail in the 1920s, and although management was directed at a single species, its impact was at the community level. Wagner, in 1969, commented that much of habitat manipulation was designed to promote individual species. Today, many management programs consider a wide range of species and promote species richness (Thomas 1979, Robinson and Bolen 1989). For example, management of wetlands may be directed primarily at increasing waterfowl production, but requirements of shorebirds, songbirds, aquatic furbearers, reptiles and amphibians are often considered. Other current examples of

the systems approach in wildlife management include old-growth forests, riparian habitats, farmland mosaics and prairies.

The systems approach to wildlife management leads to impacts on a larger scale than does species management. The impacts are beneficial over the long term and therefore are usually cost-effective. In addition, since the consequences of change are considered at the community level, the applications are usually more ecologically sound.

THE EVOLUTION OF VERTEBRATE PEST MANAGEMENT

The foundations of vertebrate pest management are based on the single-species approach; most traps, toxicants, repellents, and frightening devices were developed with individual species in mind. One of the earliest examples dates back to a ceramic trap used to catch mice in 2500 B.C. (Anonymous 1967). The first steel predator trap was designed in the late 1500s (Schorger 1951).

Toxicants, repellents and frightening devices were likely used to deal with problem species before history was recorded. Arsenic has been used as a rodenticide since the sixteenth century (Timm 1983). Seeds of (Strychnos nux vomica) were used in Europe to kill cats, dogs, and birds in 1640. The alkaloid strychnine was later extracted from these seeds in 1817. A wide variety of toxicants was developed in the 1900s. The most notable include warfarin (1948) and several other closely related first- and second-generation rodenticides; sodium fluoroacetate or "1080" (1944), first developed as a rodenticide and later as a predacide; and zinc phosphide (1911), first used as a rodenticide in Italy.

Most commercial repellents were not developed until the 1950-70s. Examples include 4-aminopyridine, ammoniated soaps of higher fatty acids, bone tar oil, capsaicin, methiocarb, and putrescent whole egg solids. Most repellents were developed with single-species efficacy in mind but many are variably effective on a variety of species.

It is quite appropriate that the majority of vertebrate pest management be directed at the species level. It will always be necessary to respond to damage caused by the activities of a single species or individual. It is also apparent, however, that vertebrate pest management has lagged behind the field of wildlife management in addressing action on the community or systems level. The systems approach to vertebrate pest management should include the consideration of all potential problem species of an area or situation and should integrate damage prevention and control strategies that minimize damage caused by those species identified as economically or socially detrimental.

I surveyed the major sources of vertebrate pest management literature from 1980 through 1989 to determine the prevalence of publications that incorporated a systems approach to vertebrate pest management (Table 1). Of the 785 papers that dealt directly with animal damage control, 11% involved the management of communities through a systems approach, while the remaining 89% addressed techniques and methodologies associated with individual species. A generic title for papers characterizing the species approach would be "The effectiveness of (technique) for controlling (species)" (i.e., Hygnstrom and Craven 1989, Hygnstrom and McDonald 1989).

I feel there are opportunities to expand the use of the systems approach in vertebrate pest management. As in wildlife management, the systems approach in vertebrate pest management, where appropriate, can lead to impacts on a larger scale than the species approach. Systems management could lead to changes in land-use and management practices or even government acquisition of lands where wildlife damage is severe and chronic (Dorrance 1983).

Table 1. Number of papers published in major vertebrate pest management literature sources[a] (1980-89) that address vertebrate pest management methods used in a species or a systems approach.

Source[a]	(volumes)	Systems	Species	Total
EB	(1)	13	260	273
VPC	(5)	24	152	176
E	(4)	18	103	121
GP	(5)	19	95	114
WSB	(10)	6	47	53
BCS	(1)	4	25	29
VPCMM	(4)	4	15	19
		88	697	785

[a]A Bibliography of Cooperative Extension Service Literature on Wildlife, Fish, and Forest Resources (EB), Proceedings-Vertebrate Pest Conference (VPC), Proceedings-Eastern Wildlife Damage Control Conference (E), Proceedings-Great Plains Wildlife Damage Control Workshop (GP), Wildlife Society Bulletin (WSB), Proceedings-Bird Control Seminar (BCS), Vertebrate Pest Control and Management Materials (VPCMM).

OPPORTUNITIES FOR THE SYSTEMS APPROACH IN VERTEBRATE PEST MANAGEMENT

A systems approach should integrate preventive measures to make an area or situation unsuitable or less attractive to all problem wildlife species that have been identified as economically or socially important. It should also incorporate control measures to remove problem individuals or to maintain populations at levels in which the damage they cause is economically and socially tolerable. The systems approach should integrate several methods, including habitat modification, exclusion, frightening devices, repellents, chemosterilants, toxicants, trapping, shooting, and other methods where appropriate. Care must be exercised that control methods, such as habitat modification, applied at the community level have minimal impacts on nontarget species (Howard 1976). The following are examples where a systems approach to vertebrate pest management should be appropriate and feasible.

Airports

There is much concern regarding public safety and economic loss at airports because of the potential of wildlife/aircraft collisions (Soloman 1981, Godin 1983). Most management efforts have been directed at reducing bird/aircraft strikes, especially those involving gulls (Larinae

spp.), waterfowl (Anatidae spp.), raptors (Falconiformes, Strigiformes spp.), European starlings (Sturnus vulgaris) and pigeons (Columba livia). There have also been problems with terrestrial mammals, including deer (Odocoileus spp.), coyotes (Canis latrans), pocket gophers (Geomidae spp.) and others. Emphasis should be directed toward habitat modification and removal, exclusion with fencing and lines, frightening devices, and population reduction.

Aquaculture Facilities

Concern stems from economic loss caused primarily by diving and wading birds and aquatic mammalian predators (Salmon et al. 1983, Parkhurst et al. 1987). Most damage control efforts have been directed at egrets and herons (Ciconiiformes spp.), gulls, mergansers and other diving ducks (Anatinae spp.), blackbirds and grackles (Passeridae spp.), belted kingfishers (Ceryle alcyon), mink (Mustella vison), otters (Lutra Canadensis) and raccoon (Procyon lotor). Emphasis should be directed toward proper facility design, exclusion with fencing, netting and lines, frightening devices, and population reduction where appropriate.

Backyards

Gardens, fruit trees, ornamentals, and other landscape plantings associated with homes are subject to a wide range of damage caused by wildlife (Salmon and Lickliter 1984, Marion 1988). Attempts to attract wildlife to backyards for aesthetic and environmental purposes often lead to unexpected damage problems (San Julian 1987). Conflicts most often involve house sparrows (Passer domesticus), European starlings, woodpeckers (Picidae spp.), roosting birds, cottontail rabbits (Sylvilagus floridanus), ground squirrels (Spermophilus spp.), moles (Talpidae spp.), opossum (Didelphis marsupialis), raccoons (Procvon lotor), skunks (Mephitis mephitis) and tree squirrels (Sciurus spp.). Emphasis should be directed toward habitat modification, exclusion with fencing, netting and lines, pest-proof feeders and houses, repellents, and frightening devices.

Crop Fields

Millions of dollars' worth of forages, row crops, and specialty crops are lost to wildlife each year (Stone 1972, Kelly et al. 1982, Hygnstrom and Craven 1986). The most notable problem species include blackbirds, deer, field rodents (Rodentia spp.), and waterfowl. Emphasis should be directed toward habitat modification and removal, exclusion with fencing, cultural controls such as damage-resistant varieties and alteration of planting and harvesting dates, repellents, frightening devices, and population reduction.

Forest Regeneration

Substantial efforts have been made to reduce the impact of deer, elk (Cervus elaphus), mountain beaver (Aplodontia rufa). pocket gophers, rabbits (Sylvilagus spp.), and voles (Microtus spp.) on natural forest regeneration, tree plantings, and nurseries (Crouch 1987). Emphasis should be directed toward habitat modification, use of damage-resistant varieties, exclusion with fencing and netting, repellents, frightening devices, and population reduction.

Livestock

Substantial research, control work and political activities have been focussed through the years on the problem of depredation of livestock by coyotes, cougars (Felis concolor), bears (Ursus spp.) eagles (Accipitridae spp.) and other predators (Wade 1980, 1982, 1986). Emphasis should be directed toward herding and herd management, exclusion with fencing, frightening devices, livestock guarding animals, and predator removal. In addition, resources used in the livestock industry such as rangeland, haystacks and grain at feedlots can be impacted by wildlife species, in particular, prairie dogs (Cynomys spp.), pocket gophers, ground squirrels, deer, elk, pronghorns (Antilocapra americana), house sparrows, and starlings (Johnson and Timm 1987). Emphasis should be directed toward range management, exclusion with fencing, pest-proof construction, and population reduction.

Orchards and Vineyards

Efforts to control damage have centered on species that cause damage to trees and vines, especially deer and field rodents, or species that damage the fruits such as blackbirds, starlings, robins (Turdus migratorius). house finches (Carpodacus mexicanus) and other fruit-eating birds (Caslick and Decker 1978, Swihart and Conover 1988). Emphasis should be directed toward habitat modification and removal, exclusion with fencing and netting, frightening devices, and population reduction.

Stored Products

Concern develops from the consumption and contamination of stored grains, feeds and foodstuffs (Jackson 1977, Bullard and Shuyler 1983, Johnson and Timm 1987). Animals commonly responsible are the commensal species, including Norway rats (Rattus norvegjcus), house mice (Mus musculus), house sparrows, starlings, and pigeons. Emphasis should be directed toward sanitation, pest-proof construction, and population reduction.

Structures

There is much concern regarding damage and nuisance problems associated with structures in urban, residential, industrial, and rural settings (Areson 1983, Johnson and Timm 1987). Again, most often the commensal species are involved. Emphasis should be directed toward sanitation, pest-proof construction, and population reduction.

Wetlands

There have been numerous efforts to reduce predator populations in waterfowl management areas. Major problem species include badgers (Taxidea taxis), coyotes, mink, raccoons, red fox (Vulpes vulpes), striped skunks, Franklin's ground squirrels (Spermophilus franklini), and bullsnakes (Pituophis melanoleucus) (Sargeant and Arnold 1984, Doty and Rondeau 1987). Although predator control is usually associated with species management, community productivity could be increased by reducing this important limiting factor. Emphasis should be directed toward habitat management and modification, exclusion and population reduction.

Windbreaks

The establishment of windbreaks requires substantial time and effort. Wildlife species can cause damage to windbreaks by feeding and other activities. New plantings are particularly susceptible (Timm 1988). Problem species include deer, pocket gophers, rabbits, hares (Lepus spp.), and voles. Emphasis should be directed toward cultural practices and habitat modification, exclusion with fencing and netting, repellents, and population reduction.

SUMMARY

Both wildlife management and vertebrate pest management have evolved through a series of stages, although it is apparent that vertebrate pest management has lagged behind in addressing the concept of systems management. The species approach will likely continue to play the major role in vertebrate pest management, but I suggest that professionals look for and be aware of opportunities for implementing the systems approach. The systems approach will likely be cost-effective and provide long-term benefits. It is proactive and will increase public awareness of the problems associated with wildlife damage. In addition, systems management can be incorporated into integrated pest management systems, low-input sustainable agriculture, and proactive interdisciplinary programming. These areas promise to be the focus of agricultural and extension programs in the 1990s and into the twenty-first century.

ACKNOWLEDGMENTS

I thank N. S. Foster and J. R. Hygnstrom for reviewing the manuscript, and J. L. Andelt for providing technical assistance.

LITERATURE CITED

ALLEN, D. L. 1974. Our wildlife legacy. Funk and Wagnals. New York, NY 422 pp.

ANONYMOUS. 1967. Man v. mouse in 2500 B.C. Sci. Amer. 216:60.

ARESON, C. W. 1983. Structural bird control - an overview. Pages 333-346 In: Proc. First Eastern Wildl. Damage Control Conf. (D. J. Decker, ed.), Ithaca, NY.

BULLARD, R., and H. SHUYLER. 1983. Springing the trap on post-harvest food losses. Horizons 2:26-32.

CASLICK, J. W., and D. J. DECKER. 1978. Control of wildlife damage in orchards and vineyards. Cornell Univ. Coop. Ext. Info. Bull. No. 146.

CROUCH, G. L. 1987. A bibliography of publications from Forest Service animal damage research in the Pacific Northwest, 1961-1986. Pages 9-14 In: Animal Damage Management in the Pacific Northwest Forests (D. M. Baumgartner, R. L. Mahoney, J. Evans, J. Caslick, and D. W. Breuer, symp. co-chrs.), Spokane, WA.

DORRANCE, M. J. 1983. A philosophy of problem wildlife management. Wildl. Soc. Bull. 11:319-324.

DOTY, H. A, and A. J. RONDEAU. 1987. Predator management to improve duck nest success. Pages 134-139 In: Proc. Eighth Great Plains Wildl. Damage Control Workshop (D. W. Uresk, G. L. Shenbeck, and R. Cefkin, tech. coords.), Rapid City, SD.

DRAHOS, N. 1951. Traps. Part 1: evolution and history. New York Conserv. 6:8-12.

GODIN, A. J. 1983. Birds at airports. Pages E95-98 In: Prevention and Control of Wildl. Damage (R. M. Timm, ed.), Univ. Nebraska Coop. Ext. Serv.

HOWARD, W. E. 1976. A philosophy of vertebrate pest control. Vertebr. Pest Conf. 7:116-120. Univ. California, Davis.

HYGNSTROM, S. E., and S. R. CRAVEN. 1986. State-funded wildlife damage programs-the Wisconsin experience. Pages 234-242 In: Proc. Second Eastern Wildl. Damage Control Conf. (P. T. Bromley, ed.). North Carolina State Univ., Raleigh.

HYGNSTROM, S. E. 1989. Electric fences and commercial repellents for reducing deer damage in cornfields. Wildl. Soc. Bull. 16:291-296.

HYGNSTROM, S. E., and P. M. MCDONALD. 1989. Efficacy of three formulations of zinc phosphide for controlling black-tailed prairie dogs. Page 181 In: Proc. Ninth Great Plains Wildl. Damage Control Workshop (A. J. Bjugstad, D. W. Uresk, and R. H. Hamre, tech. coords.), Fort Collins, CO.

JACKSON, W. B. 1977. Evaluation of rodent depredations to crops and stored products. EPPO Bull. 7:439-458.

JOHNSON, R. J., and R. M. TIMM. 1987. Wildlife damage to agriculture in Nebraska: a preliminary cost assessment. Pages 57-65 In: Proc. Third Eastern Wildl. Damage Control Conf. (N. R. Holler, ed.), Gulf Shores, AL.

KEELER, C. E. 1931. The laboratory mouse, its origin, heredity and culture. Harvard Univ. Press. Cambridge, MA

KELLY, S. T., D. A. ANDREWS, and D. T. PALMER. 1982. Bird and mammal damage to field corn in Ohio, 1977-1979. Ohio J. Sci. 82:133-136.

LAYCOCK, G. 1966. The alien animals. Nat. Hist. Press. New York, N.Y. 240 pp.

LEE, J. O. 1986. Changing times for animal damage control. Vertebr. Pest Conf. 12:2-5. Univ. California, Davis.

LEOPOLD, A. 1933. Game management. Charles Scribner's Sons. New York, N.Y. 481 pp.

MARION, W. R. 1988. Urban wildlife: can we live with them? Proc. Thirteenth Vertebr. Pest Conf. 13:34-38. Univ. California, Davis.

PALMER, T. S. 1912. Chronology and index of American game protection, 1776-1911. U. S. Dept. Agric, Biol. Survey Bull. No. 41.

PARKHURST, J. A., R. P. BROOKS, and D. E. ARNOLD. 1987. A survey of wildlife depredation and control techniques at fish-rearing facilities. Wildl. Soc. Bull. 15:386-394.

PHILLIPS, J. C. 1928. Wild birds introduced and transplanted in North America. U. S. Dcpt. Agric. Tech. Bull. No. 61.

ROBINSON, W. L. and E. G. BOLEN. 1989. Wildlife ecology and management. Macmillan Publ. Co. New York, N.Y. 574 pp.

SALMON, T. P., F. S. CONTE, and W. P. GORENZEL. 1983. Bird damage at aquaculture facilities. Pages E85-93 In: Prevention and Control of Wildl. Damage (R. M. Timm, ed.), Univ. Nebraska Coop. Ext. Serv.

SALMON, T. P., and R. E. LICKLITER. 1984. Wildlife pest control around gardens and homes. Univ. California Coop. Ext. Serv. Publ. 21385. 90 pp.

SAN JULIAN, G. J. The future of wildlife damage control in an urban environment. Pages 229-233 In: Proc. Third Eastern Wildl. Damage Control Conf. (N. R. Holler, ed.). Gulf Shores, AL.

SARGEANT, A. B., and P. M. ARNOLD. 1984. Predator management for ducks on waterfowl production areas in the northern plains. Vertebr. Pest Conf. 11:161-167. Univ. California, Davis.

SCHORGER, A. W. 1951. A brief history of the steel trap and its use in America. Trans. Wisconsin Acad. Sci., Arts, Ltrs. 40:171-199.

SOLOMAN, V. E. F. 1981. Birds and airports. Environ. Conserv. 8:45-51.

SPENCER, D. A. 1982. Vertebrate pest management and changing times. Vertebr. Pest Conf. 10:2-5. Univ. California, Davis.

STODDARD, H. L. 1931. The bobwhite quail, its habits, preservation, and increase. Charles Scribner's Sons. New York, N. Y. 559 pp.

STONE, C. P. 1972. Bird damage to corn in the United States in 1970. Wilson Bull. 84:101-105.

SWIHART, R. K., and M. R. CONOVER. 1988. Strategies for reducing wildlife damage in orchards. Connecticut Agric. Exp. Sta. Bull. 855. New Haven.

THOMAS, J. W. 1979. Wildlife habitats in natural forests-the Blue Mountains of Oregon and Washington. U. S. Dept. Agric. Handbook No. 553. U. S. Govt. Printing Office, Washington, D. C. 512 pp.

TIMM, R. M. 1983. Description of active ingredients. Pages G31-77 In: Prevention and Control of Wildl. Damage (R. M. Timm, ed.), Univ. Nebraska Coop Ext. Serv.

TIMM, R. M. 1988. Vertebrate pest management in windbreak systems. Pages 555-570 In: Windbreak Technology (J. R. Brandle, D. L. Hintz and J. W. Sturrock, eds.), Elsevier Sci. Publ. Amsterdam. 598 pp.

WADE, D. A. 1980. Predator damage control, 1980: recent history and current status. Vertebr. Pest Conf. 9:189-199. Univ. California, Davis.

WADE, D. A. 1982. Impacts, incidents and control of predation on livestock in the United States, with particular reference to predation by coyotes. Spec. Publ. No. 10. Counc. Agric. Sci. Tech. Ames, Iowa. 20 pp.

WADE, D. A. 1986. Predator damage control: 1980-1986. Vertebr. Pest Conf. 12:369-386. Univ. California, Davis.

WAGNER, F. H. 1969. Ecosystem concepts in fish and game management. Pages 687-699 In: Readings in Wildl. Conserv. (J. A. Bailey, W. Elder, and T. D. McKinney, eds.), The Wildl. Soc. Washington, D.C.